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Smart Structures for Bridges

Purdue ECT Team
Purdue University, ectinfo@ecn.purdue.edu

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EMERGING CONSTRUCTION TECHNOLOGIES

Sensors – Non-Destructive Evaluation

SMART STRUCTURES FOR BRIDGES

THE NEED

The critical deterioration of transportation infrastructure across the continent, including highways and bridges, has driven the search for new methods of concrete rehabilitation and repair. There has been a new trend in civil engineering called 'smart structures', incorporating sensors in some of the most advanced building materials. The researchers would also like to install smart structures and to develop remote systems that would allow monitoring by centrally located computers, rather than the time and expense involved in sending work crews for on-site inspections.

THE TECHNOLOGY

Researchers at University of Toronto's Institute for Aerospace Studies (UTIAS) are experimenting with a "smart" structure on the Leslie Street bridge in northern Toronto. The project, involves lining the bridge's columns with fiber optic sensors and wrapping them with advanced composite materials -- light-weight synthetic that covers the structure like plastic sandwich wrap. The wrap lessens the deterioration and holds the structure together, while the sensors precisely measure possible corrosion that may be occurring underneath. All of this means less road maintenance in general and ultimately less road closures.

The new Taylor bridge in Headingley, Manitoba is outfitted with 66 fiber optic sensors. The instrumentation in the Headingley Bridge will allow Manitoba Highways and Transportations (MHT) engineers to actively monitor the behavior of the bridge structure and the new advanced materials, over time. It will also allow dynamic sensing of singular overweight events - for example, when MHT engineers grant permission for transportation of large and overweight loads across the bridge. They[1]ll be able to see the response of the structure in real time.

The smart structure is also applied to Confederation Bridge, the longest bridge over iced-water spanning 12.9 km from Prince Edward Island to New Brunswick, Canada, to monitor the long-term effects of wind, ice and traffic loads on the bridge.

The fiber optic sensors are the same kind of hair-thin cables used in the telecommunications industry except they are wrapped around or embedded in concrete structures. Fiber optic sensing was a natural outgrowth of aerospace research, because of its use in monitoring aeronautical and space structures composed of advanced materials. The cross-over of this advanced scientific research from aerospace

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to civil engineering is exemplified by both the UTIAS Lab. and ElectroPhotonics Corp. The UTIAS laboratory is funded by Intelligent Sensing for Innovative Structures (ISIS) Canada, a federal Networks of Centres of Excellence program headquartered at the University of Manitoba.

The Benefits

The application of smart structure for bridges provides benefits:

- Less time and expenses in inspections.
- The response of the structure can be monitored remotely in real time.
- Performance of the new advanced composite materials can be monitored.

The long-term performance of advanced composite materials can be compared to conventional girders in the bridge, also outfitted with fiber optic sensors.

Status

ElectroPhotonics Corp. has installed on-site one of its commercially-available Fibre Optic Grating Strain Indicator (FOGSI) systems complete with remote monitoring capability via phone line, for querying the sensors and compiling their data. Research is currently underway between ElectroPhotonics Corp. and the UTIAS FOS Lab. to develop demodulation devices that will read and compile data from a number of sensors simultaneously.

The Canadian Precast/Prestressed Concrete Institute presented Precast/Prestressed Concrete Institute's Harry H. Edwards Award for Industry Advancement to Wardrop Engineering Inc., as well as participatory awards to the bridge owner, the Province of Manitoba; the innovator of the new technology, ISIS Canada (Intelligent Sensing for Innovative Structures); and the pre-caster, Con-Force Structures Limited.

Barriers

Fiber optic sensors is still considered to be expensive technology and no further data on the evaluation of its performance and its use as feedback in decision making process for bridge maintenance and rehabilitation processes.

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Points of Contact

Dr. Roderick Tennyson, *Director, GRIP, Univ. of Toronto*
Phone: (416) 667-7710, E-mail: rcten@utias.utoronto.ca
Dr. T. Alavie, *E-TEK ElectroPhotonics Solutions*
Phone: (905) 946-1336, FAX: (905) 946-0190

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